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STUDY OF BREAD CEREAL DISEASES IN USSR (1917 - 1942)

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Before the revolution, Russian phytopathology developed rather slowly. After the October Revolution, the study of plant diseases was considerably expedited in keeping with the general advance of agriculture which followed the end of the civil war. A number of grain institutes were founded in Moscow, Saratov, Dnepropetrovsk, Omsk, and elsewhere. Some laboratories and stations of the All-Union Institute for the Protection of Plants, e.g., those in Voronezh and Rostov, work almost exclusively on plant diseases. In addition, research institutes of Soyuzsakhar (Union Sugar), selector and experimental stations, the local STAZRA, and many other organizations have worked on individual problems in that connection. As a result, new methods for combating smuts, rust, and fusarioses have been developed. Many virus diseases, bacterial infections, and fusarioses of plants have been studied for the first time in the course of this work.

Smuts of Bread Cereals

As far as smuts are concerned, a number of chemicals for the treatment and decontamination of seed has been developed. At first, emphasis was placed on copper compounds. Copper acetate was used originally, but later A. I. Borgardt introduced AB, the active principle of which is copper oxide. AB is especially effective against the kernel or covered smuts and has been accepted as a standard seed mordant. P. N. Davydov has proposed the use of PD, which is based on calcium arsenite. Both AB and PD are being produced on an industrial scale. Their production and use are being supervised by NIUIF (Scientific Institute of Fertilizers and Insectofungicides).

The following investigators have been active in this field: A. I. Borgardt, E. E. Formin (in the Ukraine), P. N. Davydov (in Siberia), and I. G. Beylin (in Voronezh).

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At various times "khrompik" and "tal'k-arsin" were proposed by Gal'kov and NIUIF, respectively, for the dusting of seed and actually used on a large scale. The following men have worked on the control of the dusting (dry dressing) of seed and the improvement of the quality of chemicals used for that purpose: Dunin (1933, 1935), Gorlenko (1933), Murashkinskiy (1934), Vereshchagin (1935), and Pomerantsev (1935).

A study of the treatment with liquids for smuts affecting filmed [shuck-covered?] bread cerals has shown that formalin is most effective. A method has been developed for treating large quantities of seeds with formalin in such a manner that no subsequent drying is necessary. Geshele, Lopatin, and others have developed a method of chemical and thermal treatment for disinfection in combination with vernalization. Professor Strakhov and his collaborators have devised the gas-desorption method of treatment with formalin. A similar method involving the use of formalin on a filler, such as sawdust or peat, was developed by Abramov in the Far East in 1929. In this application, the powder which contains formalin is mixed with the grain. As substitutes for formalin, chlorinated lime (Ryzhkova, 1935) and superphosphate (Vasil'yevskiy, 1931), have been proposed and the use of ash and liquid manure has also been attempted (Dunin). Development of the chemical industry has led to the use of by-products of that industry for seed treatment. The most successful product of this type is the so-called condensate (Polyakov, 1940).

A method described as differentiated treatment of seeds against smuts (D. K. Rudenko, A. A. Meyer, V. A. Bryzgalova, et al.) provides for variations in the type of fungicide and its use in different concentrations depending on the stability of the grain, the degree of infection, and other variables.

Work on chemicals for combating stem smuts of rye has been carried out by Boryakovskiy (1932), and work on the stem smuts of wheat by Ul'yanishchev (1937).

Thermal decontamination as a means of combating loose smuts has acquired particular importance during the past 10 years, because the infection became prevalent after susceptible varieties of bread cereals (as, for instance, Tsezium 0111) had been introduced. Considerable work on equipment for this type of treatment has been done and the names of Proyda, Kupriyanov, Chayko, and Khodakovskiy must be mentioned in that connection. The practical application of thermal decontamination was developed by local organizations. Lopatin (Saratov), Zikherman and Samokhina (Kamennaya Steppe), Shatokhina (Odessa), and many others participated in this phase of the development. I. I. Khadakovskiy has attempted to overcome the difficulties connected with the drying of grain and has designed an apparatus for dry thermal disinfection. Murashkinskiy, Zalesskiy, Bubentsov, and Petrova have looked into the possibility of using chemical methods for preventing loose smuts, but their work has not been very successful from the viewpoint of practical application.

The importance of agricultural methods in spreading or preventing smuts has been pointed out by Strakhov and Spangenberg (1925). Borgardt, Murashkinskiy, and Ryzhkova have also done work on this subject. Davydov (1931) and Ryzhkova (1936) have emphasized the fact that agricultural equipment and packing material must be disinfected.

Efforts have been made to develop varieties of smut-resistant cereals. Fundamental investigations in this direction have been carried out by the State Commission for Testing Varieties, the experimental and selector units of NKZ (People's Commissariat of Agriculture), and those of Soyuzsakhar. Interesting work in this connection has been done at the Selection and Genetic Institute at Odessa.

Standard methods for infecting various bread cereals on an experimental scale have been worked out. In the case of kernel or covered smuts, [solid smuts in the original], wheat must be infected with smut spores amounting to 0.1 percent

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by weight. In the case of stone smuts of barley, Kutsevol (1938) has developed a method which involves raising the cuticle of the grains before introducing the spores. Fialkovskiy in Khar'kov (1936) investigated methods for infecting individual plants or whole fields with loose smuts. Later, Varmenkov (1940) designed equipment for infecting cereals with the fungi mentioned above.

Work on the specialization of the causative factors of plant diseases has been carried out especially on kernel or covered smuts of wheat. It has been established: (1) that differences in virulence do not occur within a small area (Gorlenko, Voronezh Oblast, 1936; Murashkinskiy, Siberia, 1928), and (2) that infections of different virulence are adapted either to different geographic regions (Zybina, 1937) or to different varieties of wheat. D. N. Babayan (1939), found two varieties of Tilletia tritici W., one of which was adapted to soft varieties of wheat, the other to double-grained varieties. The same also applies to T. levis. Preliminary investigations have shown that the varieties of solid smuts exhibit definite serological and biochemical differences (Tumarinson, Varga, 1936). Two varieties of Ustilago tritici have been found in Siberia -- one adapted to T. vulgare and the other to T. durum.

The resistance of cereals to smuts is of great practical and theoretical importance. Borgardt (1927) connected the resistance of wheat to kernel smuts with the energy of the growth of sprouts. Formin (1935) showed that the resistance of wheat to kernel smuts is connected with peculiarities of the sprouting of seeds. In the more resistant varieties, the sprout grows under the skin of the seed and breaks through at the opposite end, while in soft wheats the sprout immediately breaks through.

According to Shekhurdin and Vetrogradova (1935), the resistance of wheat to loose smuts is determined by peculiarities of flowering: varieties which exhibit open flowering are affected by the fungus to a greater extent.

As far as research on the biology of definite species of fungi is concerned, much valuable work has been done on loose smuts. A study of the ecology of this fungus permits prognosis of the progress of the infection in the following year. The strongest infection with this fungus occurs at a temperature of 20-25 degrees centigrade and a humidity of 50 percent or higher while the wheat is flowering (Ryzhkova, Tropova, Proyda). The physiology of the fungus has been investigated thoroughly, so that there is a sound basis for chemical treatment (Skvortsov, 1935, 1939). Work on the distribution of the mycelium of loose smuts inside the host plant was carried out by Klyushnikova (1928) and Bubentsov (1937, 1941). Knowledge of the distribution of mycelium in grain permits one to diagnose the infection in seed grain. S. T. Bubentsov also worked on the growing of cultures of U. tritici from infected seed grains.

The procedure devised by A. I. Lobik, which has been adopted as the standard method for determining the degree of infection of various cereals with surface types of smuts, must be noted. Work in this direction has been continued by Budrina and Safronova. Other methods for the diagnosis of infection of grains of wheat and barley were developed and investigated by Budrina (1936), Skvortsov (1937), Shvarts (1940), Strakhov and Shcheglov (1937). Yablokova (1936, 1937) proposed a simple method for diagnosing Ustilago tritici in wheat grains by dyeing the mycelium with a weak solution of neutral red (0.003 percent) or "Azur-Eosin."

Of considerable interest are the wet smuts of rye (Tilletia secalis Kuehn). This disease, which appears suddenly and as suddenly and unexpectedly disappears, has not been investigated at all, either from the viewpoint of the biology of the factor which produces it or measures which may be taken for combating it. Beylin (1940) discovered endemic sources of infection in the Altay mountains and determined the principal conditions which affect the development of this disease. A further study of the disease is required.

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After studying individual means and methods of preventing smuts, USSR phytopathologists have begun to plan systematic measures for combating this class of diseases. A systematic plan of procedure was originally worked out in 1931 at the First All-Union Conference for Combating Smuts. A. I. Borgardt's well-known work "Fundamentals for Planning a System of Measures for the Elimination of Smuts in the Grain Production of the USSR" (1932) furnished data for the unified plan of procedure which has been adopted.

In addition to the selection of resistant varieties, treatment of seeds, and prophylaxis by the disinfection of agricultural utensils and storage and packing facilities, measures for increasing the vigour of growth of the plants are recommended and provided for in the plan. The systematic plan was published by the NKZ, SSSR and will be revised, supplemented, and republished every year.

In recent years, three new species of smuts were discovered in the USSR. The stem smuts of wheat (Urocystis tritici Kuehn) were first found in 1930. Considerable work on this fungus was done in Azerbaydzhan, where the disease was first discovered (Ul'yanishchev, Rubinchik). The geographical limits of the infection (Azerbaydzhan, Turkmen, Tadzhik, Uzbek, Kazakh, and Kigiz SSRs and the Crimea) were determined by Rozhdestvenskiy in 1940. The disease is being fought in the following manner: strict control of the time of planting, dressing of the seeds with AB at spore contents up to 0.1 percent by weight, and treatment with formalin at higher spore contents. The resistance of wheat varieties to stem smuts has been investigated in detail (Gromachevskiy, Myakotina). The disease seems to be of local origin.

Wet smuts of barley (Tilletia pancici Bub.) were discovered by Dzhelalov in Azerbaydzhan in 1935. The fungus in question does not affect wheat.

Ul'yanishchev has described a new variety of stem smuts of rye (Urocystis secalis Uljan.) which occurs in Azerbaydzhan and apparently replaces Urocystis occulta there. Possibly it is a subspecies of the latter.

Rust of Break Cereals

The first stage of research on the subject of rust may be regarded as preliminary. It terminated approximately in 1932. The work done during that period was concerned with resistance of hosts, geographical distribution, biology of the causative factor, etc. The data obtained then were supplemented by data supplied by the computing and evaluating service of the VIZR [All-Union Institute of Agricultural Work?]. L. F. Rusakov was prominent in scientific work in that field.

The following distribution of varieties of the fungus was established:

1. Brown Rust of Wheat

Occurs throughout the USSR, but is more prevalent in the south, because the higher temperatures favor survival during the winter and facilitate development. A special form, isopyri, which requires an intermediate host, occurs in Siberia.

2. Stem Rust of Cereals

Fairly widespread, but causes damage only in regions where the common barberry or the Amur barberry occurs (Northern Caucasus and the Far East, respectively).

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3. Crown Rust of Oats

The principal damage is caused in the central and southern belts of the USSR, but only in regions which are overgrown by buckthorn, its intermediate host (Rhamnus cathartica, Daur buckthorn, or Pallas buckthorn).

4. Yellow Rust

Climatically adapted to the northwestern regions of the USSR and the foothills of Transcaucasia, Central Asia, and Altay. The possibility exists that there are two forms of this fungus which differ with respect to optimum conditions of temperature and moisture required.

5. Brown Rust of Rye

Widespread, but does not cause much damage, because the plants reach maturity before the disease has had a chance to develop.

6. Dwarf Rust of Barley

Causes damage only to winter barley on which it survives the winter. Gorlenko and Naydenko (1938) and also Khokhryakov (1941) point out that barley may also be infected by the brown rust of wheat.

In connection with the general survey outlined above, a characterization of the varieties of wheat and oats known and cultivated at the time of the survey was given by Rusakov.

The second period of work on the subject of rust was characterized by efforts to devise effective measures for combating this class of diseases. The incentive for this work was given by violent outbreaks of almost all types of this group of fungus infections in 1932 and 1933, resulting in great material losses. A draft of a systematic plan for combating rust was prepared and submitted to the First All-Union Conference for Combating Rust in Stavropol, in July 1937. The measures discussed there were finally adopted at a conference on rust held at the NKZ, SSSR in November of the same year and were published in the form of instructions.

All varieties of rust were divided into two groups according to the type of revival in the spring. In the first group, emphasis was placed on the extermination of intermediate hosts, while in the second the protection against infected windfall [plants remaining in the fields] was stressed. During the second period, the methods for exterminating intermediate hosts were investigated very thoroughly. Thanks to the work by the Voronezh and Rostov STAZRA (carried out by Gorlenko and Kikoina, respectively), standard procedures for this purpose now exist.

The third period of investigation in this field was marked by a more concentrated study of the rust of bread cereals, in the course of which many valuable publications have appeared. It has been established that indigenous varieties of Thalictrum function as intermediate hosts transmitting the brown rust of wheat (Yeremayeva, 1926). However, later investigations showed that the part played by these plants in the spring revival of brown rust is insignificant (Gorlenko, 1936; Bryzgalova, 1937; et al.). A new intermediate host of this disease, which is specific for Eastern Siberia and is of considerable importance there, was found in Isopyrum fumarioides (Bryzgalova, 1937).

A number of investigations have demonstrated the exceptional importance of Rhamnus cathartica in the recurrence of crown rust of oats (Gorlenko, Grushevoy, Kuz'michev, Rusakov, et al.). These investigations formed the basis

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for combating the disease in question. A new intermediate host of crown rust in oats was discovered, Pallas buckthorn, which transmits this rust in the Northern Caucasus (Shumilenko, 1940).

For the first time, the importance of couch grass (Agropyron repens) and other weeds in bringing about the recurrence of rusts in cultivated cereals could be established. It was shown that weeds might conceivably form a link between the barberry and cultivated cereals in transmitting rusts (Novitskiy, Khokhryakov, Kon'kov, and Gorlenko).

Thanks to the very interesting work done by M. K. Khokhryakov on intermediaries and transmitters, the classification of rust fungi occurring on bread cereals has been revised. Khokhryakov is of the opinion that Puccinia triticina is only a variety of Puccinia persistens. This species, in his opinion, has three varieties: f. tritici, f. tritici isopyri, and f. agropyrina. A detailed study was made of the strain composition of the principal species affecting bread cereals. Extensive work on the brown rust of wheat was carried out by Rashevskaya, Barmenkov, Gorlenko, Geshele, Obermeyster, et al. The geographic distribution of strains, the type of adaptation to hosts, the affect of ecological peculiarities on the development of the fungus, the reactions of standard and projected varieties of wheat to different strains of the fungus, etc., have been studied. The most prevalent strains of brown rust were found to be strains 20, 17, 64, and 67.

Less extensive work was done on strains of stem rust (Barmenkov, 1940) and crown rust of oats (Petrusheva). Barmenkov constructed a camera which permits a simultaneous estimate of the degree of susceptibility of any variety to several infecting strains.

In regard to brown rust, Kargopolova (1937) related the susceptibility of varieties of wheat to the phenol content of leaves, while Kudryavtseva (1940) established a connection between resistance to infection and the activity of proteolytic enzymes. Fedotova brought out the connection between resistance to rust and immunological properties of plasma proteins.

Rusakov (1926) pointed out for the first time that the brown-leaf rust of wheat winters on wheat. Stepanov showed that it is the uredomycelium rather than the uredostage which winters. He established the dependence between the development of the uredostage and the temperature of the air. Data obtained in the course of this work permit short-term prognoses of rust development.

Work by Naumova (1937), in regard to the influence of external factors on the appearance of rust, has led to the construction of nomographs for brown and yellow rust. These nomographs permit short-term prognoses of the appearance of rusts.

During this period, Rusakov prepared a final classification of bread cereals, according to susceptibility to rust, and read a report on it at the First Conference for Combating Rust in 1937. At this time, many new varieties of rust-resistant cereals were introduced into agriculture. The best varieties of wheat from that viewpoint were found among the Luk'yanenko-Voroshilovka hybrids. Other varieties also proved to be resistant. As far as oats were concerned, Verkhnyacheskiy 339, the varieties developed by the Mironov station, Stepnyak 0648, and others were adopted as resistant varieties. Similar work was also done on other cereals. To estimate the progress achieved thereby, one must note that almost all bread cereals of prerevolutionary selection were highly susceptible to rust.

During the third period under consideration, several interesting publications appeared. Among them may be mentioned: (1) a monograph on rust of bread cereals in the USSR by N. A. Naumov; (2) a number of booklets on rust compiled on the basis of local data and reflecting the status of research in the regions in question (Gorlenko-Voronezh Oblast; Kikoina-Rostov Oblast; Kuz'michev-Ordzhonikidze Kray; Dorozhkin-Belorussian SSR, etc.); (3) results of the First All-Union Conference for Combating Rust; and (4) research by Geshele (1941) on phytopathological evaluation in selection.

Ergot

Experimental work on ergot (spur of rye) was not carried on during recent years. However, a compilation of the world literature on the subject was made by N. A. Rozhdestvenskiy and published in 1926. Aside from that, there are several publications describing outbreaks of ergot poisoning among the population. In 1939, a publication by Vladimirskiy appeared, which outlined the principal USSR geographical zones exposed to damage by ergot. In the compilation of Vladimirskiy's report, extensive data supplied by the Service of Disease Estimation were used. Of great interest is the work on fundamental aspects of the prognosis of ergot infections initiated by P. A. Proyda, which, unfortunately, has not yet been completed.

Bacterial Diseases of Cereals

The discovery and study of bacterial diseases of cereals in the USSR took place after the October Revolution. The first reference to bacterial diseases of cereals was made in a paper published by Professor A. A. Yachevskiy in 1926. Somewhat later, Fomin made a thorough study of black chaff. Subsequently the bacterial diseases of wheat were investigated by Trunov (1939) in the Ukraine and Gorlenko (1933 - 1939) in Voronezh Oblast.

The degree of damage caused by the so-called black bacterial infection was found to reduce the yield from diseased ears by as much as 50-90 percent as compared with sound ones. The annual recurrence of the disease is caused by seeds and to some extent by remainders from the previous year's crop. The seed can be disinfected only if the interior of the grain, as well as the surface, is affected by the method of treatment. From this viewpoint, thermal treatment must be regarded as effective.

A considerable amount of work has been done in evaluating species and varieties of wheat in regard to their susceptibility to black bacterial infection. As far as soft wheats are concerned, it has been found that red-eared wheat (Ferrugineum, Mil'turum) is more strongly affected, while white-eared wheat (Lyutestsens or Velyutinum) is more resistant. The wide prevalence of black bacterial infection of wheat has stimulated energetic research on the disease. The results of this research were discussed in February 1941 at the Microbiological Conference in Leningrad. In discussing the role of bacteria in the development of the disease, some participants in the meeting, Gorlenko, Belen'kiy, and Formin, emphasized the infectious nature of the disease; while others, Oksentyan and Rudakov, ascribed the blackening of ears mainly to physiological factors.

Trunov (1939) and Gorlenko (1939) proposed a tentative systematic plan of procedure for combating black bacterial infection. The Khar'kov Selector Station has developed Yubileynaya (Jubilee) winter wheat which is resistant to black bacterial infection and is replacing susceptible varieties.

As far as other bacterial diseases of cereals are concerned, work has been done on Bact. atrofaciens (Galach'yan, 1941) and the bacterial spotty disease of oats (Gorlenko and Naydenko, 1941).

Virus Diseases of Cereals

Virus diseases of cereals have only recently been investigated. Work on "zakuklivan'ye" [literally, pupation] of cereals was done by Sukhov and Vovok at the Institute of Microbiology, Academy of Sciences USSR, while Zazhurilo and Sitnikova worked on the mosaic of winter wheat at the Voronezh STAZRA. The knowledge gained in the USSR on these two specific diseases is much more thorough than any available information on similar diseases based on research done abroad.

"Pupation" of cereals is transmitted by the dark minor cicada. The distribution of the disease, the cycle of botanical vectors, and the anatomical and cytological peculiarities of diseased plants have been definitely established. Evaluation of varieties with regard to resistance has been carried out (Rusakov, 1941). As far as concrete measures for fighting the disease are concerned, reference may be made to the work done by Sukhov, Vovok, Bryzgalova, Grebenshchikova, Tsygankova, and others.

As far as the mosaic disease of winter wheat is concerned, this was recognized as a virus disease in 1936. Gorlenko, Zazhurilo, Sitnikova, and to some extent, Shvarts have worked on the subject. It has been shown that mosaic differs from "pupation" in the sense that no protein crystals can be found in the cells by the usual analysis in cases of inosaic. These crystals appear only after treatment of cuts with hydrochloric acid. The insect transmitting the disease is the striped minor cicada. The relation between the insect vector transmitting the disease and the virus was investigated, and measures for combating mosaic were devised on this basis.

Resistance of wheat depending on the genetic background was also investigated. In the course of this work, a great number of varieties were evaluated. The work of the Voronezh STAZRA (Zazhurilo and Sitnikova, 1937 - 1941) has supplied impetus to further investigation of the mosaic disease of cereals elsewhere. The work of Broyakovskiy in the Ukraine and Ryakhovskiy's work at the Ramon' Experimental Station may be mentioned in that connection. According to Ryakhovskiy, the incidence of wheat mosaic can be lowered by proper fertilization of the soil.

At the Moscow conference on virus diseases, in February 1940, ten pages out of 37 were devoted to virus diseases of cereals.

Powdery Mildew of Cereals (Erysiphaceae)

The study of this disease was begun quite recently at the Voronezh Station for Plant Protection. Gorlenko (1940) investigated the biology of this fungus on wheat. He established that the fungus mostly does not winter in the pouch stage on remainders of crops, but in the form of little pillows and of the mycelium on winter plantings. The pouch stage only preserves the fungus during the period between the harvest and the appearance of the first sprouts of winter wheat. To prevent infection, any plants which remain in the fields must be destroyed before the appearance of the first sprouts of the winter planting.

When plants are weakened by drought, they are more susceptible to powdery mildew. A study of resistance, as determined by genetic composition, demonstrated that there are many species and varieties of both summer and winter wheat which are immune to powdery mildew. Moreover, some of the varieties which resist powdery mildew are also resistant to brown rust.

Helminthosporioses of Cereals

The most harmful, and, hence, most intensively studied diseases of this group are: (1) the black germ of seeds; (2) root decay; and (3) the striped disease of barley.

The black germ infection has been investigated thoroughly in the Ukraine (Fomin and Nemliyenko), in Siberia (Ziling), and in the VIZR (Tropova). The main cause of infection is the fungus Helminthosporium sativum and, more rarely, the Alternaria tenuis. The disease reduces the yield and lowers the percentage of seeds which grow after being planted. Damage due to the disease increases when the humidity is high during the period of flowering of the wheat. Although hard wheats are more seriously affected, there are resistant varieties even among hard wheats. Fomin and Nemliyenko advocate thermal treatment as a preventive for black germ disease.

Root decay is another form of infection by the same fungus (Tupenevich et al.).

The striped disease of barley (Helminthosporium gramineum R.) is the most harmful disease of barley. It causes even more damage than loose smuts and other infections of this type. The only effective methods of treatment are those resulting in disinfection of the interior part of the grain, such as thermal treatment (Naydenko, 1940, in Voronezh; Znamenskiy, 1940, in Zapolyar'ye) or dressing with mercury compounds (NIUMF-1, mercury substituted aniline, etc.), according to a suggestion made by the Institute of Insectofungicides. The Khar'kov Selector Station (Proyda, 1940) worked on the selection of resistant varieties. The biology of the striped diseases of barley was studied at VIZR by Kuprianova (1940). She found that harvest remainders and stubble remaining in the ground may cause reinfection in the following year.

Fusarioses

Among diseases of this group "intoxicated" bread, root decay, and snow wilt have been studied most thoroughly.

The work of Naumov on "intoxicated" bread was already available in 1917. Later the subject was studied by Dunin (1926) and Abramov (1939). Abramov investigated the bioecology of the disease and suggested measures for fighting it. He established that there are varieties of wheat which have a considerable amount of resistance to the disease, e.g., Lyutestsens 062 and a number of Far Eastern wheats, including Amur golokoloska (naked ear), Mestnaya (local) eritrospermum, and Shtrube. The "intoxicated" bread infection is essentially produced by two fusariums, Fusarium graminearum and F. avenaceum. These species and several others (F. calmorum) may also induce other types of cereal diseases, such as white ear, the loss of sprouts, pink bloom on ears, loss of productive stems, etc.

These diseases were thoroughly studied by Tupenevich (1932 - 1941). He found that the main causes of the diseases are Fusarium avenaceum, F. culmorum (in the northern belt), F. herbarum, F. avenaceum (in the middle belt), and F. graminearum (in the southern, very moist regions). Purely agricultural measures comprising correct planting, adequate fertilization, etc., are the most effective means of combating fusarioses. Hard and late-ripening varieties are especially affected by this class of diseases, while soft and rapidly-ripening varieties are more resistant.

Pisarev and Malinovskiy (1939) concluded that the cultivation of summer wheat in Moscow Oblast hinges on the introduction of varieties which would be resistant to fusarioses, and that it is entirely possible to introduce such varieties. Agronomov, Dunin, et al. (1935) made a detailed study of the microbiology and biochemistry of fusarium-infected grains of stored wheat.

Snow wilt, which is caused by Fusarium nivale, was studied by Tetrevnikova (1926), Yachevskiy (1922), Broyakovskiy (1928) and, later on, more thoroughly by Tupenevich. The fungus which causes snow wilt is capable of developing at low temperatures, so that the disease sets in whenever there is a thaw. Snow wilt develops on weakened plants; therefore, all measures which strengthen the plants are effective in preventing damage from this infection.

Markovich (1939), in studying the genetic background of resistance of winter wheats to snow wilt, showed that northern ecological types of winter wheats are least affected by this disease, having adapted themselves to it in the region where the disease is most prevalent. Southern ecological types, on the other hand, are more susceptible.

Tupenevich (1940) established that varieties having a short vernalization period are more strongly affected than varieties having a long vernalization period. The most resistant wheat are Kostromka 028, Batetskaya belokoloska (white ear), Mestnaya bezostaya, Lyutestsens 020, and Eritrospermum 0329.

Sclerotinum Disease of Winter Cereals Caused by Sclerotinia Graminearum Elen

Although this disease has been known for a long time, it was not described until 1920 by P. F. Elenev. Since then, periodic outbreaks of the sclerotinum disease have occurred with increasing frequency and have been recognized. The following investigators have worked on the sclerotinum disease: Fokin (1925), Khokhryakov (1935), Fokin (1939), Sol'kina (1939), Yakovlev (1939), Tupenevich (1939, 1940), and Pukhal'skiy (1937). As a result of their work, a thorough knowledge of the disease has been acquired. It is possible that the disease is due to a weakening of the plants which results from delayed thawing of a thick snow blanket. Instructions for fighting the disease were published by the People's Commissariat of Agriculture in 1940. Preventive measures comprise correct procedures in regard to planting and cultivation and more rapid melting of the snow.

Other Diseases of Bread Cereals

A number of diseases have been investigated only incompletely and sporadically. Among these may be mentioned:

1. Species of the genus Septoria were studied in detail by Demidova (1926) in regard to their genetic composition. The late L. S. Gutner started a monograph on the subject (Naumov, 1940). There are fragmentary data on the resistance of wheat to species of Septoria.

2. Rynchosporium graminicola of barley, which causes much damage in the south, has not been investigated at all. There is only one publication on the subject (Kostychev, 1935).

3. Dilophospora alopecuri, which had been noted only once by Gorlenko in Voronezh Oblast in 1937, has not been studied at all, although according to Atanazov, it occasionally causes heavy damage abroad.

4. In 1939, Shchitikova called attention to the spotty disease of rye caused by Scolechotricum graminis. According to her, this infection may be of considerable importance, although it has not been studied at all.

5. Species of Sclerospora, which had been described only in one instance (by Garbovskiy in 1915 in the former Podol'sk government) may be of local importance. Recently, N. A. Naumov described a new species of this genus which is parasitic on rye in Kotlas Rayon of Arkhangel'sk Oblast.

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Conclusion

During the period under consideration, Russian phytopathology has progressed considerably and has reached the level of contemporary international science. Further investigations should concentrate on questions connected with immunity of bread cereals to infection.

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